Malaria Outbreak investigation in Chitulipasi, Beitbridge District, Matebeleland South Province, 2015

Roy Tapiwa Chiruvu [1], Blessing Kanengoni [2], More Mungati [1], Notion Tafara Gombe [1], Donewell Bangure [1], Mufuta Tshimanga [1], Maxwell Mhlanga[1]

1. Department of Community Medicine University of Zimbabwe, Harare, Zimbabwe
2. International Organization for Migration, Harare, Zimbabwe

Corresponding Author: - Maxwell Mhlanga profmaxmhlanga7@gmail.com

Email addresses:

RTC: rchiruvu@gmail.com

BK: bkanengoni@iom.int

MM: mungatim@yahoo.com

NTG: gombeng@yahoo.com

DB: bangured@yahoo.com

MT: tshimangamufuta@gmail.com

Abstract

Background: Cases of Malaria at Chitulipasi clinic in Ward One of Beitbridge district surpassed epidemic thresholds from week 9 through week 15. In total 223 cases were recorded in ward one from weeks 9 to 15. We investigated the outbreak of malaria in Ward One.

Methods: A one on one unmatched case control study was conducted among residents in Ward One. A case was a person from Ward One who presented to Chitulipasi clinic with sudden onset of intermittent fever associated with any of the following; shivering, sweating, joint and muscle pains, nausea, vomiting, diarrhoea and headache and was diagnosed malaria with Rapid Diagnostic Testing, from weeks 7 to 15 of 2015. Sixty cases and 60 controls were systematically and randomly selected respectively. Written informed consent was obtained from all study participants. Data were analysed using Epi Info.

Results: Females constituted 53.3% (n=32) and 55.0% (n=33) of cases and controls respectively (p=0.86). The median ages in years were 22 (Q_1=13; Q3=37) and 23 (Q_1=17; Q3=35) for cases and controls respectively (p=0.95). Staying in house with closed eaves (OR 0.05 95% CI 0.01, 0.40), staying 3km away from stagnant water body (OR 0.30 95% CI 0.13, 0.70) and having a net hanging per sleeping space (OR 0.07 95% CI 0.03, 0.17) were significant protective factors for contracting malaria.

Conclusion: The outbreak was driven by staying near stagnant water, staying in houses with open eaves and not using a mosquito net. Emphasis on larviciding, utilization of nets and sleeping under nets should be made. Health education was provided to the community.

Key Words: Malaria Outbreak, Risk Factors

Introduction

Malaria continues to place significant morbidity and mortality in many parts of the world especially developing countries. Globally, there were about 198 million cases of malaria and an estimated 584,000 deaths in 2013 [1]. Most deaths occur among children living in Africa [2]. Malaria mortality rates have fallen by 47% globally and by 54% in the African region in 2013 [1]. In 2013, 90% of malaria deaths were in the World Health Organization (WHO) African region, mostly among children under 5 years of age [3]. Increased malaria prevention and control measures are dramatically reducing the malaria burden in many places. However, movement of people is the means by which malaria is being dispersed with the international transportation of artemisinin-resistant parasites being the greatest threat to the anti-malarial treatment used in Africa today [4].

Zimbabwe recorded a marked decline in malria incidence during the past decade. Howver, the country is not on track to meet its set Millennium Development Goal (MDG) 6 target of incidence less than 15 cases per 1000 population by December 2015 [5]. The current malaria mortality rate in Zimbabwe stands 21 per 1000 population for children under 5 years [6]. An estimated 98% of cases of malaria in Zimbabwe are due to *Plasmodium falciparum*. The remainder is accounted for by *Plasmodium ovale* and *P. malariae* [7]. *Anopheles arabiensis* is the main vector for malaria transmission. During the period of 2012-2013, malaria was the leading cause of outpatient attendances at health facilities in Zimbabwe, after acute respiratory infections and HIV [8].

Clinically malaria is characterized by the appearance of fever, headache and vomiting 10 to 15 days after the mosquito bite. If not treated, malaria can quickly become life-threatening by

disrupting the blood supply to vital organs. In many parts of the world, the parasites have developed resistance to a number of malaria medicines. Integrated Vector Management (IVM) to control malaria in Zimbabwe include use of insecticidal nets, indoor residual spraying (IRS) with insecticide, larviciding and environmental management [9].

Persistent malaria outbreaks and high incidence rates in the east and north border districts of Zimbabwe have been attributed to the lack of a comprehensive vector control programme and ill stocked health facilities. Vector control is the backbone for malaria control in Zimbabwe. Over the years it has demonstrated high impact results [6]. The goal of the extended National Malaria Strategic plan is to reduce malaria incidence from 22/1000 in 2012 to 10/1000 in 2017 and malaria deaths to near zero by 2017. One of the main objectives of the plan is to detect 100% of epidemics within one week of onset and effectively managing 100% of malaria epidemics within two weeks of detection. The objective has three important strategies: (1) early detection and response to epidemics, (2) resource mobilization for detection and effective management of epidemics and (3) capacity development at implementation level for effective management of epidemics [5].

The average monthly incidence of malaria in Beitbridge district is less than 10 cases per 1,000 populations. Statistics from the weekly disease surveillance system in Beitbridge district revealed that from week seven of 2015 there was an increase in the number of malaria cases in the eastern parts of the district. Chitulipasi clinic in ward one was most affected, with the number of cases reported surpassing epidemic thresholds from week nine through week 15 by over 100%. From week nine to week 16, 223 cases of malaria were reported at Chitulipasi clinic. We present results of our investigation of this outbreak.

Materials and Methods

An unmatched one on one case control study was carried out among residents of Ward One, Chitulipasi Catchment area in Beitbridge district. A case was a person who resided in Ward One who presented at Chitulipasi clinic with sudden onset of intermittent fever associated with any of the following; shivering, sweating, joint and muscle pains, nausea, vomiting, diarrhoea, headache and was diagnosed of malaria using Rapid Diagnostic Testing (RDT), from week seven to week 15 of 2015. A control was a person who was a neighbour of a case residing in Ward One and who tested negative to RDT from weeks 7 to 15 of 2015.

The calculated required minimum sample size was 60 cases and 60 controls. The line list at Chitulipasi clinic was used as a sampling frame. The sampling frame for cases had 242 line listed cases. Systematic sampling of cases was done, firstly by using a random number table to select the first case. A sampling interval of 4 was used to select the other participants on the line list until the sample size of 60 cases was reached. A missing case or a case that refused to participate was replaced by the next case on the line list according to the sampling interval. The sampling frame (from hospital registers) for controls included residents of Chitulipasi (ward 1) who tested negative on RDT for malaria and were from the same neighbourhood as cases. A control was randomly selected from the neighbourhood of a case.

District Environmental Health Officer, the Environmental Health Officer at the district level, the District Pharmacist, the Health Information Officer, the Laboratory scientist, the District Nutritionist (a Public Health Specialist) and the area Health Orderly and Sister-In-Charge at Chitulipasi clinic were purposively recruited into the study as key informants to assess the epidemic preparedness and response of the district.

Cases and controls were visited at home for the interviews where an interviewer administered questionnaire was used. Data on demographic characteristics, risk factors associated with contracting malaria, knowledge and practices vis-à-vis malaria was solicited for. Checklists were used to assess availability of resources and the district health team's preparedness and response. An environmental assessment was conducted to identify environmental risk factors for malaria.

The presence of stagnant water bodies (e.g. open ponds) and anopheles mosquito larvae which characteristically rest parallel to and just below the water surface were identified. We also compared the coverage for Indoor Residual Spraying (IRS), larviciding and Long Lasting Insecticide Treated Nets (LLNS) in Chitulipasi catchment area of Beitbridge against set targets. An interview guide for key informants was used to elicit more information on the district's epidemic preparedness and response.

Data were entered into Epi-info version 3.5.3 statistical software and the same software was used to analyze the data, draw the epi curve and calculate frequencies, means, proportions and odds ratios. All calculations were done at 95% confidence intervals. The same package was used to perform Chi-square test of association to test for statistically significant differences between cases and controls' exposure to risk factors, calculate odds ratios, confidence interval and p-values.

Permission to conduct the study was obtained from the Health Studies Office (HSO), the Provincial Medical Director (PMD)-Matebeleland South Province, the District Medical officer (DMO)-Beitbridge and the local traditional leadership in Chitulipasi Ward One. Written informed consent was obtained from all study participants. In the case of a minor who could not

legally consent informed consent was obtained from a parent or guardian. Confidentiality and anonymity was maintained from data collection through data analysis, storage and reporting.

Results

Socio-demographic characteristics

Both cases (60) and controls (60) were comparable with respect to socio-demographic characteristics (**Table 1**). Females constituted 53.3% (n=32) and 55.0% (n=33) of cases and controls respectively (p=0.86). The median ages in years were 22 (Q_1=13; Q3=37) and 23 (Q_1=17; Q3=35) for cases and controls respectively (p=0.95). Most cases (56.7%) and controls (51.7%) had primary as their highest level of education (p=0.09). The majority of cases (35%) and controls (31.7%) were farmers (p=0.45). The median years in service or key informants was 7 (Q_1=3.5; Q_3=10).

Risk factors for contracting malaria

Staying in a house with closed eaves (OR 0.05 95% CI 0.01, 0.40), staying 3km away from stagnant water body (OR 0.30 95% CI 0.13, 0.70) and having a net hanging per sleeping space (OR 0.07 95% CI 0.03, 0.17) were significant protective factors for contracting malaria (**Tables 2 and 3**). Staying in a sprayed house (OR 0.47 95% CI 0.07, 2.36) was protective but not statistically significant. Spending early hours of evening indoors (OR 1.43 95% CI 0.68, 3.00) was risk although not statistically significant.

Environmental Assessment

Active mosquito breeding sites were identified and Larviciding was done starting mid-March 2014 up to April in different areas including Chitulipasi dam, Shashashe Rivers (two of them), Chishala and Malabe Rivers. Tall grass was found mostly around cases homes.

Emergency Preparedness and Response

The outbreak was detected on the 23rd of February 2015 (week nine); a day after the action threshold was surpassed by over 100% (**Figure 1**). The District Medical Officer (DMO) initiated investigation and control measures on the 20th of March 2015 (week 12). A team comprising of Environmental health practitioners, nurses and laboratory technicians camped at the health facility for three days, during which mass screening of community members, intensive case finding (RDT tests of people including those apparently well) and follow-up, health education, case management and larviciding were done. There-after the district also visited and supported the clinic staff, in outbreak response (investigation, larviciding, contact tracing and treatment of cases), weekly until the end of the outbreak. Line lists were compiled. Cases peaked in weeks 11 and 13. The outbreak was declared over in week 20.

Village Health workers conducted health education, malaria testing and referring positive cases to the clinic for treatment. The Emergence Preparedness and Response (EPR) committee did not routinely conduct meetings and the last meeting with available minutes was convened on 25 April 2015. There was no copy of an EPR plan at the health facility although a spot map was displayed, filled regularly and being used for mapping cases of malaria. Integrated Disease Surveillance and Response (IDSR) manuals and malaria case management guidelines were available at district and health facility level. There were no records to indicate the numbers of staff trained in either IDSR or malaria case management at district level. None of the key informants knew the proportion of health workers who were IDSR trained in the district. The outbreak ended in week 17 of 2015.

Outbreak emergency kit, standard treatment protocols and Rapid Response Team were available at Chitulipasi Clinic. Four out of five health workers at Chitulipasi clinic were trained in IDSR.

IDSR meetings were done monthly. EPR plans were not available at the clinic. Drug stocking levels were above required minimum stocking levels at the clinic. Information, education and communication materials were limited.

On average, cases reported for treatment at the health facility after two days. Cases were treated according to malaria case management guidelines for Zimbabwe. Confirmation of malaria was done through RDT and two out of 60 cases were severe and complicated. Uncomplicated cases were treated using co-artemether and paracetamol. Complicated cases were referred to the district hospital for further management. Two pregnant women were among the cases. Both had received Fansidar (for Intermittent Preventive Therapy) at sixteen weeks, in line with guidelines. All cases reported that they finished the treatment course. There were no deaths recorded at the clinic.

Discussion

The epidemic curve had several peaks typical of a multifocal malaria outbreak suggesting multiple outbreak sources. Multiple mosquito breeding sites were identified, mostly within 3km from homesteads of cases. Chitulipasi is located at the confluence between Bubi and Limpopo rivers and there are lot of potential water collecting bodies (potential breeding sites) particularly during the rainy season. This exposes residents to mosquito bites and malaria infection.

Staying away from stagnant water bodies was protective. This implied that longer distances away from stagnant water bodies reduced risk of residents being bitten by mosquitoes. Consistent findings were also made by Chinhengo et al, Marape et al and Matare et al [10, 11, 12]. Wearing protective clothing and using mosquito repellents among other protective measures as informed by the Integrated Vector Control Management (IVCM) should be emphasized in this community.

Hanging a mosquito net, used as a proxy to sleeping under a mosquito net, was a significant protective factor for contracting malaria in Ward One. Mosquito nets acted as barriers between persons and mosquito bites. A consistent finding was made by Maenzanise that using a mosquito net was protective [13]. Emphasis should be placed on utilizing supplied mosquito nets.

Staying in a house with closed eaves was a significantly protective factor in this outbreak. A study by Matsvimbo et al also noted that staying in a house with open eaves was a risk factor for contracting malaria [14]. Open eaves facilitate entry of mosquitoes into the house that increasing exposure of residents to the mosquito bites. The implication in this finding is that residents should keep their eaves closed to reduce the risk of mosquito bites.

Staying in a house that was sprayed (recent spraying in December 2014) was protective but not statistically significant. This could be raising serious questions about the effectiveness of the spraying technique used in this area, resistance of mosquitoes to chemicals, monitoring and evaluation of the indoor residual spraying (IRS) program or behavior of humans following spraying. Some residents could be sleeping outside rooms due to hot weather conditions. Some could be sleeping in the fields overnight protecting their crops from wild animals. Therefore, this is area which may need further investigation.

In contrast to the studies by Marape et al and Matare et al, spending time outdoors (by the fireplace) was protective whereas staying indoors during the early hours of the evening was risky although not statistically significant [11, 12]. This is consistent with findings by Maenzanise et al in Msampakaruma, Kariba, which found sitting outside the house and around the fireplace to be protective [13].

Despite proper case management and proper control measures (health education, mass screening and larviciding), response to the outbreak was delayed. The District Health Executive (DHE) should improve in terms of timeliness especially considering that they are in the pre-elimination phase of malaria. Otherwise, they may regress to the consolidation phase of malaria.

This study had some limitations. Recall bias could have caused differential recall of exposure information between cases and control. This could have therefore threatened the validity of our findings. The sample size was too small. The study could have been not powerful enough to pick significant changes on some exposure variables.

Conclusion

The outbreak was driven by staying near stagnant water, staying in houses with open eaves and not sleeping under a mosquito net. Notably, staying in a sprayed house and spending early hours of the evening indoors were protective and risk respectively but not statistically significant. Although the clinic was prepared for the outbreak, response to it by the DHE was untimely.

Recommendations

- Community health clubs could be used to strengthen behaviour change communication regarding malaria in the community, especially promoting consistent use of LLINs.
- Emphasising on undermined protective interventions like use of repellents and long clothing during the night. This is especially important in the wake of complains by communities against some irritating chemicals which make the use of mosquito nets unwelcome

Public Health Actions

Health education was provided to the community in Chishala and Chamalime villages at the end of the investigation.

Acknowledgments

We would like to express my sincere gratitude to the staff at the International Organisation for Migration (IOM) for their support. Special thanks go to the staff in the Master of Public Health field office for all the help they rendered. We would also like to express our profound gratitude to Centres for Disease Control (CDC) Zimbabwe for funding and technical input. Many thanks go to all participants for their consent to allow us to interview them. Last, but not least, we would like to thank our families for social support throughout the project.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

RTC: conception, design, acquisition, analysis and interpretation of data and drafting the manuscript. BK: conception, design, data collection, analysis, interpretation and reviewing of several drafts of the manuscript for important intellectual content. MM: conception, design, acquisition, analysis and interpretation of data and drafting the manuscript. NTG, DB: conception, design, acquisition, analysis and interpretation of data and drafting the manuscript. MT: conception, design, acquisition, analysis and interpretation of data and drafting the manuscript. All authors read and approved the final manuscript.

References

1. World malaria report. Geneva, World Health Organisation. Ministry of Health and Child Care (MOHCC), *2014. Zimbabwe National Malaria Control Program Database.*
2. World Health Organization, 2014. *Fact Sheet No. 94*. 2013
3. World Health Organization. 10 Facts about malaria, 2015.
4. Lynch C. and Roper C., *The Transit Phase of Migration : Circulation of Malaria and its Multidrug - Resistant forms in Africa*, London School of Hygiene and Tropical Medicine, London, United Kingdom. 2011
5. Ministry of Health and Child Care (MOHCC). *National Malaria Strategic Plan 2008 - 2013, extended to 2015(NMSP)*. 2007
6. Ministry of Health and Child Care (MOHCC). *Cross Border Vector Control Proposal*: Joint Zimbabwe and Mozambique Collaboration. 2014
7. Ministry of Health and Child Care (MOHCC). *Malaria Indicator Survey*.2012
8. Zimstat. *Quarterly Digest of Statistics*: 2nd Quarter 2014.
9. Dhege C, Zizhou S.T , Muyengwa P: *Malaria outbreak investigation in wards 4, 5 and 6, Mudzi District, Mashonaland East Province* 2012 (unpublished).
10. Chinhengo T, Chihanga S, Chirenda J: *Malaria Outbreak Investigation in Gokwe South-Nemangwe Area 2004.* 2004
11. Marape G, Mpeta E.T and N Ndlovu: *Investigation of malaria outbreak at St Luke's hospital, Lupane district, 2008.* 2008

12. Matare T, Chemhuru M, Takundwa L, Gombe N, Tshimanga M, Bangure D, Mungati M. *Factors Associated with Malaria Infections in Ward One, Beitbridge District, Matebeleland South Province, Zimbabwe, 2014.* 2014 (unpublished).
13. Maenzanise S R, Kusangaya O, Chirenda J and Tshimanga M: *Malaria Outbreak Investigation in Msampakaruma, Kariba District, Zimbabwe.* 2004
14. Matsvimbo P, Mberikunashe J and Shambira G: *Factors associated with contracting malaria in Chiredzi district (ward 21), Masvingo Province,Zimbabwe 2014.* 2014 (unpublished)

Table 1: Socio-demographic Characteristics of Malaria Cases and Controls in Chitulipasi, Chitulipasi, Beitbridge District, Zimbabwe 2015

Variable		Cases n=60 (%)	Controls n=60 (%)	p-Value
Age	≤ 5 years	7 (11.7)	4 (6.7)	
	6-19 years	22 (36.7)	20 (33.3)	
	20-34years	15 (25.0)	20 (33.3)	
	35 years+	16 (26.7)	16 (26.7)	
Median Age (Q_1: Q_3)		22 (Q_1=13;Q_3=37)	23 (Q_1=17;Q_3=35)	0.95
Sex	Male	28 (46.7)	27 (45.0)	0.86
	Female	32 (53.3)	33 (55.0)	
Education	None	19 (31.7)	11 (18.3)	0.09
	Primary	34 (56.7)	31 (51.7)	
	Post Primary	7 (11.7)	18 (30.0)	
Occupation	Farmer	21 (35.0)	19 (31.7)	0.45
	Schooling	14 (23.3)	3 (5.0)	
	Teacher	0	2 (3.3)	
	Vendor	0	12 (20.0)	
	Other	2 (3.3)	5 (8.3)	
	None	23 (38.3)	19 (31.7)	
Religion	Apostolic	16 (26.7)	19 (31.7)	0.84
	Orthodox	24 (40.0)	16 (26.7)	
	Pentecostal	3 (5.0)	6 (10.0)	
	Muslim	0	1 (1.7)	
	Traditional	17 (28.3)	18 (30.0)	

Table 2: Risk factors for contracting Malaria in Chitulipasi, Ward One, Beitbridge District, Zimbabwe 2015

Factor	Exposure status	Cases n =60 (%)	Controls n=60 (%)	Odds ratio (95%CI)	p-Value
Staying in a house with closed eaves	Yes	1 (1.7)	15 (25.0)	0.05 (0.01 - 0.40)	0.0001
	No	59 (98.3)	45 (75.0)		
Stay ≥3km away from stagnant water	Yes	10 (16.7)	24 (40.0)	0.30 (0.13 - 0.70)	0.0085
	No	50 (83.3)	36 (60.0)		
Sleep under a mosquito net 'last night'	Yes	31 (51.7)	36 (60.0)	0.71 (0.35-1.47)	0.3580
	No	29 (48.3)	24 (40.0)		
Use mosquito repellents	Yes	7 (11.7)	9 (15.0)	0.75 (0.26-2.16)	0.7883
	No	53 (88.3)	51 (85.0)		
Sprayed house	Yes	54 (90.0)	57 (95.0)	0.47 (0.07-2.36)	0.2453
	No	6 (10.0)	3 (5.0)		
Spending early hours of evening indoors	Yes	25 (41.7)	20 (33.3)	1.43 (0.68–3.00)	0.346
	No	35 (58.3)	40 (66.7)		
Brick under asbestos	Yes	19 (31.7)	28 (46.7)	0.52 (0.25-1.11)	0.092
	No	41 (68.3)	32 (53.3)		

Table 3: Risk factors for contracting Malaria in Chitulipasi, Ward One, Beitbridge District, Zimbabwe 2015®

Factor	Exposure status	Cases n (%)	Controls n (%)	Odds ratio (95%CI)	p-Value
Net hanging	Yes	14 (23.7)	42 (82.4)	0.07 (0.03-0.17)	0.0000
	No	45 (76.3)	9 (17.6)		
Conventional repellents	Yes	2 (28.6)	3 (33.3)	0.80 (0.094 – 6.848)	0.6346
	No	5 (71.4)	6 (66.7)		
Whiling up time by the fire place (outdoors) in the evening	Yes	24 (68.6)	28 (70.0)	0.935 (0.350 –2.499)	0.894
	No	11 (31.4)	12 (30.0)		

®These factors were not applicable to all participants and the sample size is less the calculated sample size